

Defense Supply Center Philadelphia
West Coast Support Office

Pest Management Techniques

Stored Product Arthropod Pest Pheromone Trapping

Stored Product Arthropod Pest Management

Introduction

Stored-product insects cause significant losses to stored foods. Losses may be minimized when infestations are quickly identified and the appropriate control measures implemented. Methods of identifying stored-product insect infestations: product inspections (receipt, warranty, cyclic and issue), walk-through (visual) inspections, customer complaints, and accidental discovery by personnel. Product and visual inspections, although necessary, are both labor-intensive and time-consuming activities. Product inspection is subject to "luck of the draw" in finding an actual infestation when low level infestations are involved.

Numerous methods for detecting stored-product insects, particularly food pests, have been investigated. The most useful technique, currently available and continuously refined, is monitoring storage facilities with insect pheromones and/or food attractants. This technique is an essential component of an effective integrated management program for stored-product pests.

The incorporation of monitoring methods into existing stored-product pest management programs can lead to earlier detection of low level infestations and pinpointing hidden infestations. Monitoring has several distinct advantages. Monitoring information can be used to justify a reduction in pesticide use or the need for intensified surveillance and other pest management procedures. Monitoring results can also serve as an indicator of how well integrated pest management (IPM) program components are functioning.

The following information is designed to provide a general understanding of monitoring methods and programs. Detailed information on individual monitoring methods and insect monitoring systems can be found in journal articles, research reports, and manufacturers' literature

Definitions

Food Attractant. An oil or food extract (non-nutritive products are preferred) or synthesized scent that will attract a select group of insects. In some cases the food attractant is impregnated into an artificial medium. Oil food attractants are also used as killing agents for the trapped insects.

Food Attractant Trap. A device using a food attractant to attract insects. It is used for monitoring a group of insects (e.g., stored-product insects, soil insects). Some traps are designed to retain attracted insects. They are often combined with pheromone lures in a single trap.

Incubation. Process or procedure of keeping material in a favorable (optimum) environment in order to hatch or stimulate development of organisms/life stages (eggs, larvae, spores, bacteria, etc.) that may be present.

Lure. A small rubber or plastic device impregnated with or retaining a pheromone or food attractant. Lures are designed to release materials gradually over a designated period of time, either passively or by controlled release.

Pheromone. A chemical compound produced by an organism that initiates a behavioral activity in others of the same species. Pheromones are identified and synthesized to attract target insect species.

- **Aggregation pheromone.** A communication chemical predominantly produced by males that attracts both sexes. Effective compounds have been synthesized for stored-product insect species with long-lived adults (e.g., *Tribolium*) and species that need to feed to reproduce.

- **Sex attractant pheromone.** A communication chemical usually produced by females. It attracts the opposite sex. Effective compounds have been synthesized for stored-product insect species with short-lived adults (e.g., *Lasioderma*) and adults that do not need to feed to reproduce.

Pheromone Trap. A device utilizing a pheromone lure that attracts and retains insects, used primarily for monitoring particular species. However, in some situations these traps can aid in the suppression of insect

populations. Pheromone traps may be combined with food attractants in a single trap.

Detection/Monitoring Methods

Pheromone/Food Attractant Traps (PFAT): Pheromones have been identified for many of the stored-product insects. Some synthesized lures have been commercially developed and a variety of trap designs are available. Traps have been very effective for monitoring commodities having few species of stored-product pests (e.g., tobacco). PFAT monitoring has the potential for early detection of low-level and isolated infestations of certain stored-product insects.

Advantages of PFAT Monitoring

- a. PFATs provide twenty-four hour a day monitoring.
- b. PFATs target a defined area of the warehouse/facility.
- c. PFATs help in pinpointing the location of an infestation, including within-structure infestations.
- d. PFATs can reduce the amount of pesticide used for control by targeting the specific area to be treated and indicating when applications are necessary.
- e. PFATs can reduce the amount of product lost by early detection of insect activity.
- f. PFATs are easily moved around in a warehouse.
- g. PFATs are nontoxic.
- h. PFATs do not involve additional product inspection (unless an infestation is indicated).
- i. PFATs provide tools for evaluation of current pest management procedures.
- j. PFATs are not labor intensive.
- k. PFATs supplement other existing surveillance programs.

Disadvantages of PFATs.

- a. Some traps will collect insects other than the target species; this can be advantageous in some circumstances.
- b. Collected specimens can be difficult to remove intact from the PFAT for identification.
- c. Some trap designs do not work well in dusty areas.
- c. Floor-placed traps may frequently be lost or damaged.

Trap Selection

Pheromone lures have been developed for several stored-product insects (Tables 1 & 2). Currently, the lures developed for species with short-lived adult stages have proven to be more effective. However, good results have also been attained with the lure for lesser grain borer (*Rhyzopertha dominica*). At a minimum, traps utilizing lures for *Trogoderma* spp., cigarette beetle (*Lasioderma serricorne*) and flour beetles (*Tribolium* spp.) should be used in subsistence areas. Indian meal moth (*Plodia interpunctella*) traps, in addition to the beetle traps, should be considered for use in commissary storage areas.

Food attractant lures for stored-product insects (predominantly oil lures consisting of oat oil, wheat germ oil extracts and mineral oil) are used for species having long-lived adults and for some larvae. These lures may be used with or without pheromones. In general, these lures have a smaller effective range than pheromone lures. They have been reported effective for sawtoothed grain beetle (*Oryzaephilus surinamensis*). They can be used to enhance the effectiveness of pheromone traps for the flour beetles and to attract Khapra beetle/warehouse beetle (*Trogoderma* spp.), *Attagenus*, and *Anthrenus* larvae. Oil baits should not be used beyond their indicated shelf life.

(1) The oil lures oxidize and solidify over time. Collected specimens may have to be freed from the oil before they can be identified. Polymerized oils need an aromatic solvent (xylene).

(2) Researchers have used sesame oil in Khapra beetle traps as a substitute for the standard oil lure. Sesame oil can be quickly dissolved with a 5% detergent solution (a non-sudsing detergent such as

automatic dishwasher detergent must be used for vacuum filtration of the rinsate). This method removes most of the oil from the collected specimens.

Lures for different species can be combined into a single trap

Cigarette beetle, warehouse beetle, lesser grain borer and *Tribolium* lures can be combined, as these insects are active on the floor or at relatively low levels in the warehouse. Lures for species that are active fliers can also be combined in a single trap (e.g., wing or hanging delta trap). Some traps are designed to hold as many as four different pheromones plus a food oil attractant. However, some researchers suggest a maximum of three pheromone lures plus the oil. At this time, there have not been reports of inhibition effects by combining lures in a single trap.

The *Tribolium* lure should not be combined with an Indian meal moth lure due to the marked difference in flight activity of these insects.

Facilities that monitor specifically for Khapra beetle can place *Trogoderma* lures in suspended traps as well as wall-mounted or floor traps. The suspended traps will attract non-Khapra *Trogoderma*. Since Khapra beetles do not fly, these specimens would not require Khapra beetle verification. This will reduce the number of beetles requiring verification. Khapra beetle is a quarantine insect, and if suspected must have its identification confirmed by an expert in Khapra beetle taxonomy. (Note: Unless a CONUS facility receives material from another region of the world, especially Northeast Africa or Southwest Asia, it is unlikely the facility would have Khapra beetle. However, any collected specimens suspected of being Khapra beetle should be checked.)

There are a variety of trap designs (Appendix B). The adhesive surface of some traps is exposed (wing type, e.g., LasioTrap?) and can quickly become coated with dust and dirt. For dusty areas, the pitfall, funnel or other covered trap design would be more appropriate.

PFAT Placement in Food Warehouses with Infestible Products

The initial trap density will vary according to the species of insect and the pheromone used. For Indian meal moth, the trap density should be about 1 trap per 25,000 cu ft. Beetle traps should be arranged in a grid pattern at intervals of 25 to 50 ft. Infestations can be pinpointed by increasing the trap density around areas suspected of containing infested stores.

Traps may be placed outside the warehouse and away from the building to determine if an infestation(s) is originating from an external source.

To reduce the chance of attracting insects from outside the facility, traps should not be placed within 30 ft of exterior doors or open windows.

Traps should be placed to minimize damage to the traps from normal facility operations.

a. Most beetle traps are designed to lie flat. However, depending upon design, some traps can be mounted on vertical structures/walls, pallet rack systems or pillars.

b. Wing type and most funnel traps need to be suspended, which can limit their placement in warehouses. Nevertheless, they should be placed as close to dry pet food and breakfast cereal areas as possible because these products are prone to infestation by Indian meal moth. The traps can be hung from small pulleys over or near pallets, allowing them to be out of the way but still accessible. The trap height for Indian meal moth can range from 6-30 ft.

If highly infestible products are consolidated into a few areas, trap placement can be concentrated in those areas.

Trap Monitoring

In temperate climates, PFATs should be utilized from at least April 1 through October 31. In warm climates or where heated warehouses are utilized, year-round monitoring is recommended.

Pest management personnel should maintain an accurate map or listing of trap locations.

Traps should be checked on a weekly basis, and a log or record sheet of catches should be maintained. Trap and/or lure replacement and other actions should be documented for maintenance purposes or precision targeting.

NOTE (PROCEDURE)

A warehouse which contains infestible commodities should monitor for the following arthropod pests (those listed in red are most commonly observed and at the minimum should be included in a pheromone trapping program):

If possible combine locate all infestible commodities in a single area of the facility.

Deploy an appropriate number of wing or diamond traps located approximately 6 to 10 feet from the floor. Traps must be mapped. Each wing or diamond trap mounted at 6-10 feet may contain lures for the following pests:

Indian Meal Moth
Tobacco Moth
Raisin Moth

Each wing or diamond trap mounted closer to package surface or floor level (i.e., 2-3 feet) may contain lures for the following pests:

Cigarette Beetle
Drugstore Beetle
Lesser Grain Borer
Warehouse Beetle

Each surface mounted beetle trap (FliteTrack) may contain lures for the following pests:

Flour Beetles
Sawtoothed Grain Beetle
Warehouse Beetle
Drugstore Beetle
Cigarette Beetle

For those traps that contain insects:

- a. Determine if the target stored-product insects were collected.
- b. Record the number of each species/type collected.
- d. To prevent specimens from being recounted on sticky traps, they should be removed or marked or the trap should be replaced.

If justified, trap density should be increased in the area where activity is evident. This will help pinpoint the location of the infestation. These additional traps should be checked daily.

Appropriate pest management procedures should be implemented when a stored-product infestation is located. After the insect source is eliminated, monitor the facility at the former trap density.

Traps will collect non-target insects that wander into them. It is advisable to have a verified, representative reference specimen collection available to aid in identifications or in separating target from non-target insects.

The presence of large numbers of a non-stored-product insect (e.g., Phoridae, Psychodidae, Drosophilidae) in traps indicates other potential pest management problems in the warehouse (e.g., leaking product, dirty drains, etc.) that need to be located and eliminated.

Trap Maintenance

Replace damaged and dirty traps as necessary. Lures from such traps should be reused if possible. Moth lures may be used up to 6 months and beetle lures 1 to 3.5 months, depending on the specific lure. Damaged or unusable lures must be destroyed and not left on or near the premises because these lures can attract insects.

Lures should be handled with tweezers (forceps) or rubber gloves to avoid contamination of the lure. Staples or other fastening methods that damage the surface of a lure can reduce its longevity and/or effectiveness.

Unused lures should be stored in a refrigerator or freezer to reduce oxidation and to maintain their shelf life of approximately 2+ years. Refer to the manufacturer's instructions that accompanied the lures for specific product information.

Traps require regular monitoring and good maintenance of the bait or attractant. If neglected, traps may become the foci for infestations. The more rapid monitoring techniques used in precision targeting may eliminate the need for trap maintenance.

Interpretation of Trap Catch for Target Species

The catch over time for the trap at each location is evaluated instead of the total catch for all traps in a warehouse or bay. The trends and patterns for the collections in each trap are what is important.

a. 1-2 specimens collected in a week at scattered locations. If this situation occurs infrequently, then the catch is probably incidental. The specimens probably wandered in or came in on pallets or packaging.

b. A few (2-5) specimens collected on a regular basis in the same location. This catch probably represents a small infestation. The trap density in the area of the suspected infestation should be increased and product inspection considered. Exception: The trapping efficiency for dermestid larvae is not as high as with a sex attractant. A catch of more than 1 larva in a week requires greater scrutiny of an area and a catch of greater than 2 should be considered a probable infestation.

c. Several (6-9) specimens collected weekly. This catch indicates that a small to moderate infestation may be present. Trap density and monitoring frequency should be increased to identify the extent of the infestation. Product inspection should be initiated.

d. Numerous (10+) specimens collected in a trap. This situation indicates that an active infestation is present and that immediate action should be taken to isolate and control the stored-product pest. Product inspection is necessary. Additional traps should be placed in the area to aid in determining the extent of the infestation.

NOTE: The above numbers are to be used as guidelines. There are no "magic" or standardized numbers to correlate trap catches to actual infestation levels. Each storage facility must be evaluated individually. Generally, any deviation from a normal trend or baseline indicates a point where additional integrated pest management actions are necessary. Additionally, if Khapra beetle is collected and verified from a CONUS facility, USDA eradication procedures must be followed.

Trap catches also can be used to determine the seasonality and migration of the target species at a storage facility. This information can be used in refining the pest management programs for the facility.

SOME EXAMPLES OF PHEROMONE TRAPS USED FORMONITORING STORED-PRODUCT INSECTS

1. Cardboard Beetle Traps: The trap has a corrugated cardboard insert that holds the lure(s) and a plastic tray for the food attractant.

a. Vertically mounted trap. This trap is designed primarily to trap Khapra beetle and other *Trogoderma* species. It uses a food oil to attract; larvae and pheromone for adult males. The trap mounts on walls and pillars and is less likely to be damaged by activities in its environs.

b. Horizontally positioned traps. This style of trap uses food oil lure to attract larvae or beetles with long adult stages (e.g., sawtoothed grain beetle and *Tribolium* spp.) and up to 4 lures. The trap needs to lie flat to prevent spillage of the oil attractant. **Note: placement of these traps requires great care to prevent spilling the oil during normal warehouse operation.**

2. Other Beetle Traps:

a. Cigarette beetle trap. This trap was designed specifically for the cigarette beetle. The trap needs to stand upright and should not be used in dusty areas.

b. Savannah trap. This trap is for *Tribolium* spp., *Oryzaephilus* spp., and *Lasioderma* spp. The trap can be placed on the floor or mounted on a shelf. It is a modified pitfall trap that incorporates a pheromone bait and food attractant. This trap works well in dusty areas.

3. Hanging Traps: These traps are designed primarily for moths, however they will also collect flying beetles (e.g., cigarette beetle, lesser grain borer, flying species of *Trogoderma*). Multiple lures can be placed in each trap.

a. Delta trap. A durable trap design that uses replaceable glue-coated inserts for collecting insects. Open on the ends only.

b. Wing trap. A three-piece trap. The bottoms are replaceable and available with grids.

c. Diamond trap. The trap is a one piece design.

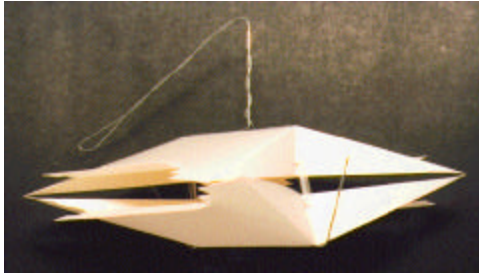
d. Hanging pitfall trap. This trap is constructed of rigid plastic. It is designed for long-term use and has a large capacity. The trap requires either liquid or other material (e.g., a piece of “no-pest strip”) in the bottom to kill the collected insects. The pheromone lure mounts in the top of the trap.

Standard Insect Monitoring Systems, Pheromones, and Replacement Kits

National Stock Number	Manufacturer & Part Number	Comments
3740-01-418-1632	Agrisense 121101	
6840-01-418-1927	Agrisense 121901	One hundred wing traps per box.
6840-01-418-1929	Agrisense 122514	Twenty-four per bag. 1 year shelf life at room temperature, 2 years shelf life if refrigerated, and 3 years if frozen.
6840-01-418-1933	Agrisense 122313	Twelve "trappit" vertical wall mount monitoring traps with lure for detection, monitoring, and control of <i>Trogoderma</i> beetles.
6840-01-414-8117	Trece 3653-13	Pherocon 1C trap kit: 3 traps, 3 sticky liners, and 3 lures.
6840-01-414-8118	Trece 3153-25	Twenty-five per bag. 1 year shelf life at room temperature, 2 years if refrigerated, and 3 years if frozen.
6840-01-414-8123	Trece 3156-25	Twenty-five per bag. 1 year shelf life at room temperature.
6840-01-414-	Trece 3155-25	Twenty-five per bag. 1 year shelf life at

8124		room temperature.
6840-01-414-9391	Trece 3565-05	Flite-Trak kit for Khapra and warehouse beetles. 1 year shelf life. Kit contains 5 traps, 5 lures, and food oil attractant.
6840-01-414-9393	Trece 3566-05	Flite-Trak kit for red and confused flour beetles. 1 year shelf life. Kit contains 5 traps, 5 lures, and food oil attractant.
National Stock Number	Manufacturer & Part Number	Comments
6840-01-414-9395	Trece 3567-05	Flite-Trak kit for sawtoothed grain and merchant beetles. Kit contains 5 traps and oil food attractant (no pheromone lures).
6840-01-414-9397	Trece 3162-25	Twenty-five lures per bag. 2 year shelf life if refrigerated or frozen.
6840-01-414-9399	Trece 3158-25	Twenty-five lures per bag. 1 year shelf life at room temperature.
6840-01-418-5107	Trece 3302-00	Pherocon IC traps. 100 per case.
6840-01-418-5110	Trece 3303-25	

(A)



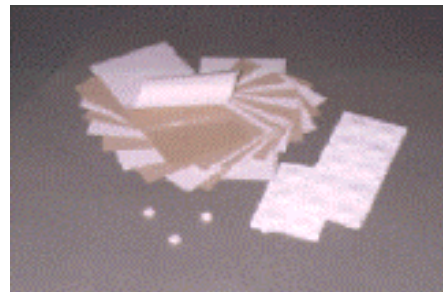
(B)



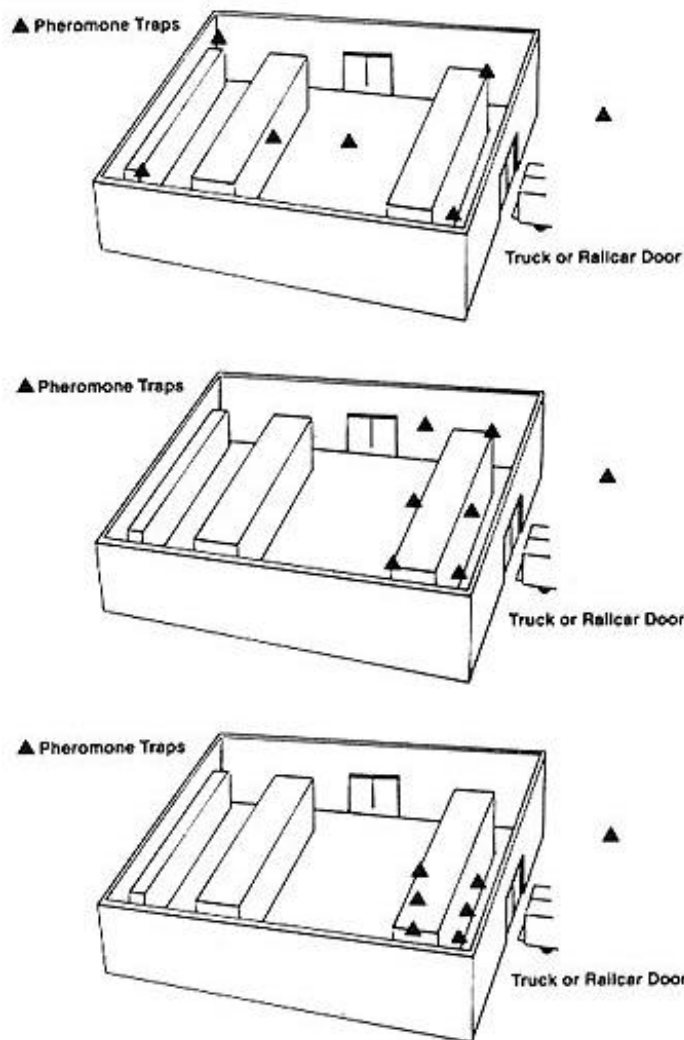
(C)



(D)



Surveillance Traps: (A) Wing Trap, (B) Diamond Trap, (C) Pitfall FLITeTRAK M2, (D) Glue Board



Typical placement of pheromone traps in a warehouse.

This example illustrates a situation where one trap per 100,000 cubic feet is placed in a finished grocery product warehouse. The pest management inspector checks each trap weekly. A record of the results is kept in a separate log away from the physical trap itself. A map should be made of each trapping location. Each trap in this practical example contains two lures: 1) *Plodia* complex (Indianmeal moth), and 2) *Trogoderma* complex (warehouse beetle, *T. glabrum*, furniture cabinet beetle, khapra beetle). An optional lure for the cigarette beetle could be placed in each trap in some situations.

For further information regarding rodent pest management, contact your local pest management professional or DSCP-WCSO at DSN 686-8122, commercial 510-337-8122 or email at paa5245@exmail.dscp.dla.mil.

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